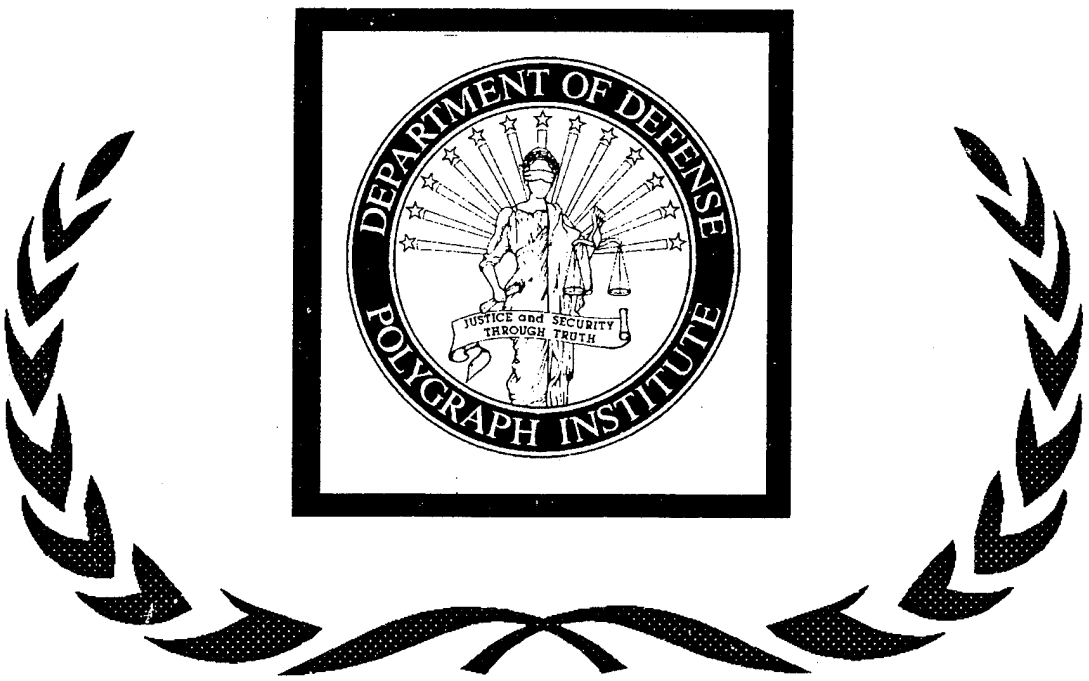

A Comparison of Signals from Two Occlusive Cuff Cardiovascular Sensors Used for the Psychophysiological Detection of Deception

Victor L. Cestaro, Ph.D. and Andrew B. Dollins, Ph.D.

July 1994

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13. ABSTRACT *(Maximum 200 words)*

This study was designed to investigate the correlation between cardiovascular signals measured during a psychophysiological detection of deception (PDD) examination using the occlusive arm and finger cuffs. Twenty subjects completed a number search task and participated in a PDD examination where the questions addressed the number circled during the number search task. Half of the subjects circled numbers within the range of the PDD questions and half circled numbers outside of the range. Dependent measures included the time-locked amplitudes of electrophysiologic signals measured from the occlusive arm and finger cuffs. The degree of correlation between these measures was assessed. The Pearson correlations between the right finger cuff and the left arm cuff were 0.90 or higher for 379 of 529 (72%) data pairs. The correlations between the left finger cuff and the left arm cuff were equal to or greater than 0.90 for 219 of 523 (42%) data pairs. These results, and practical considerations, suggest that the occlusive finger cuff tested (Lafayette Model 7620) is not a viable alternative to the traditional arm cuff. A finger cuff may, however, be more sensitive to peripheral blood volume changes than the arm cuff and a less problematic design should be investigated.

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July 1994

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Fort McClellan, Alabama 36205

Director's Foreword

This is the first study, in what will be a series of studies, to explore a variety of sensors for recording cardiovascular physiological activities (CPA). The purpose of this line of research is to find a sensor for recording CPA that will: (1) be easier to quantify; (2) be more sensitive to basic CPA; (3) not cause discomfort to the examinee; and (4) allow lengthier test formats should circumstances require them.

Other sensors to be studied are the Finapres; the Cortronic; the Impedance Cardiograph; various Systolic Time Intervals; Pulse Wave Velocity; a variety of Thumb Cuffs; the Plethysmograph; and the Cardiovascular Activity Monitor. The description and function of these other sensors will be presented in the final research reports associated with each sensor.

The results of this study suggest that the Lafayette Thumb Cuff Model 76520 is not the appropriate sensor for usage in the psychophysiological detection of deception. Other commercial thumb cuffs, as well as those developed by Institute researchers, will be studied as time and priorities permit.

William J. Yankee, Ph.D.
Director

Acknowledgements

The authors would like to thank the volunteers who participated in the study, as well as Charlene L. Stephens and MSG Chris Harlow for their assistance throughout data acquisition. This research was supported by DoDPI94-P-0011 project funds from the Department of Defense Polygraph Institute. The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

Abstract

CESTARO, V. L., and DOLLINS, A. B. A comparison of signals from two occlusive cuff cardiovascular sensors used for the psychophysiological detection of deception. July 1994, Report No. DoDPI94-R-0002. Department of Defense Polygraph Institute, Ft. McClellan, AL 36205. This study was designed to investigate the correlation between cardiovascular signals measured during a psychophysiological detection of deception (PDD) examination using the occlusive arm and finger cuffs. Data collected during this study were used to examine the viability of the occlusive finger cuff as an alternative to the occlusive arm cuff currently used in PDD examinations. Because the finger cuff is more comfortable than the arm cuff, its use will allow examiners to ask more questions per test and facilitate development of new, longer, test question formats. Twenty subjects participated in this study. They were asked to complete a number search task (circle a specific set of two-digit numbers within a block of two-digit numbers) and participate in a PDD examination conducted by a Forensic Psychophysiologist. The PDD examination questions addressed the number circled during the number search task. Half of the subjects circled numbers within the range the questions included and half circled numbers outside of the range. Each subject completed one examination (three tests per examination). Testing conditions and question order were constant across all subjects. Dependent measures included the time-locked amplitudes of electrophysiologic signals measured from the occlusive arm and finger cuffs (i.e., amplitudes were time-locked, relative to question offset). The degree of correlation between these measures was assessed. The Pearson correlations between the right finger cuff and the left arm cuff were 0.90 or higher for 379 of 529 (72%) data pairs. The correlations between the left finger cuff and the left arm cuff were equal to or greater than 0.90 for 219 of 523 (42%) data pairs. These results, and practical considerations, suggest that the occlusive finger cuff tested (Lafayette Model 76520) is not a viable alternative to the traditional arm cuff. A finger cuff may, however, be more sensitive to peripheral blood volume changes than the arm cuff and a less problematic design should be investigated.

Key-words: cardiovascular, occlusive arm cuff, finger cuff, blood volume

Executive Summary

CESTARO, V. L., and DOLLINS, A. B. A comparison of signals from two occlusive cuff cardiovascular sensors used for the psychophysiological detection of deception. July 1994, Report No. DoDPI94-R-0002. Department of Defense Polygraph Institute, Ft. McClellan, AL 36205.

The major source of physical discomfort associated with a psychophysiological detection of deception (PDD) examination is the occlusive cardiovascular cuff used to measure changes in blood volume. This cuff is similar to the traditional blood pressure cuff and is composed of a bladder, which is positioned over the brachial artery, embedded in a wide strap secured around the upper arm. The bladder, which must remain inflated throughout testing to acquire accurate blood volume measures, can cause mild to severe discomfort depending on the inflation pressure and duration. The maximum practical duration of a PDD test is limited by the degree of discomfort to 13-18 questions, approximately 5 to 6 minutes. The cardiovascular cuff thus limits the number of questions which can be asked and has sometimes resulted in accusations of unnecessary duress by examinees. The current study was completed to determine whether a more comfortable, commercially available, finger cuff could replace the traditional cardiovascular arm cuff. Replacement of the occlusive arm cuff would reduce complaints of discomfort and permit the implementation of longer, possibly more accurate, testing.

Twenty male and female subjects participated in a PDD examination concerning a number search task. Throughout the examination blood volume changes were measured using a traditional arm cuff and two finger cuffs (placed over the left and right thumbs). Pearson product correlations were calculated to determine the degree of similarity between signals measured from the arm and finger cuffs in response to each question. No efficacy assessment was made of either cuff, only the degree of measured signal similarity. Correlations between the right finger and left arm cuffs were 0.90 or greater for 379 of 529 (72%) of the trials. Correlations between the left finger and arm cuffs were 0.90 or greater for 219 of 523 (42%) of the trials. It is concluded that the low consistency of signal similarity indicates that the blood volume measurement techniques are not comparable. The amplitude variability and number of baseline adjustments made suggest that the finger cuff may be more sensitive to peripheral blood volume changes than the arm cuff. It is, however, recommended that finger cuffs of the design tested not be used during PDD examinations due to excessive bladder leakage and susceptibility to changes in barometric pressure. The design and testing of a less problematic occlusive finger cuff is recommended.

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The psychophysiological detection of deception (PDD) is a technique used by the United States government, various state and local law enforcement agencies, and officers of state and local courts, to determine an individual's truthfulness concerning topics of interest (Office of Technology Assessment, 1983; Lykken, 1981). In theory, the subject's physiologic reactivity varies with the personal relevance of presented stimuli and, more so, with attempts to conceal that relevance from the PDD examiner. In the field the variability in Skin Conductance Response (GSR-SCR), respiratory rate and/or volume, and heart rate/blood pressure are typically assessed. Increased reactivity, defined as an increase or decrease in rate and/or amplitude of responding, depending on the measure in question, to some stimuli but not others is assumed to reflect the personal relevance of the stimuli presented to the subject. The typical PDD examination is designed to elicit physiologic responses to specific questions from the subject regarding topic(s) of interest. Those physiologic responses are subsequently scored by one or more methods and interpreted as indicative of the subject's response truthfulness.

Currently the number of questions asked during a single test is limited by the degree of discomfort the subject experiences due to inflation of the occlusive cardiovascular arm cuff. Yankee (1965) reports that discomfort is first experienced by male and female subjects an average of 2.0 minutes after cuff inflation (90, 100, and 110 mmHg) and severe discomfort an average of 5.5 minutes after cuff inflation. Additionally, there are dangers associated with the occluded venous return of blood to the heart when the arm cuff is left in place for prolonged periods of time, and the side effect of production of reactions in other autonomic measures (Davis, 1961). Use of a more comfortable sensor would allow examiners to conduct longer, possibly more accurate, PDD examinations.

The current investigation was designed to compare the signals acquired using occlusive finger cuffs to those acquired using an occlusive arm cuff during a PDD examination. Correlations equal to or greater than 0.90 would demonstrate that the signals from the two sensors are comparable.

Method

Subjects

Twenty healthy, native English speaking, male and female subjects between the ages 19 and 30 years participated in the study. All subjects completed an informed consent affidavit (Appendix B), approved by the Department of Defense (DoD) Polygraph Institute Human Use Committee, prior to participation.

Examiner

The same examiner conducted all PDD examinations. The examiner completed training at the Department of Defense Polygraph Institute (Ft. McClellan, AL) and was certified as a polygraph examiner by the Department of the Army. He had administered approximately 300 field examinations during the 7 years prior to the study.

Apparatus

Data were collected using a Lafayette Factfinder (Model 76740/76741) polygraph equipped with three Cardio/Aux/Pneumo/GSR modules (Model 76477-G). Lafayette sensors were used to collect cardiovascular data at the arm (Model 76530) and both thumbs (Model 76520). A custom built interface was used to amplify and adjust the zero baseline of the analog signals, which were ported to a computer containing an analog-to-digital converter. Amplifier gains for digitized data were fixed to provide 10:1 amplification for the finger cuff channels and 5:1 gain for the arm cuff channel, independent of the examiner's adjustments to the polygraph instrument's sensitivity and centering controls. The analog data were digitized and stored on the computer disk for off-line analysis.

The PDD examination questions were recorded to eliminate volume and inflection variance. Each PDD examination question was digitized and recorded to computer hard disk using a Sound Blaster board (Model 16ASP, Creative Labs Inc., Milpitas, CA). A parallel port interface (Speech Thing, Covox Inc., Eugene, OR), connected to a Radio Shack (Fort Worth, TX) integrated stereo amplifier (Model SA-155) and two speakers (Model Minimus-77), was used to present the questions. An IBM compatible 286 computer was used to replay questions during testing.

Procedure

Subjects were randomly assigned, a priori, to the treatment or control groups with the constraint that no more than three subjects from each group were tested consecutively. They initially reported to the reception desk at the DoD Polygraph Institute (Building 3195, Ft. McClellan, AL) and were escorted to a secluded room within the building for briefing. Prior to testing, they were asked to read a short description of the project which explained the investigation purpose and procedures, as well as participant requirements, rights, and risks (Appendix A). Any questions the subject had were answered during this time. Subjects were asked to sign an informed consent affidavit (Appendix B).

Subjects were then required to accurately locate, on pre-printed forms, six sequences of five adjacent repetitions of a two-digit value in a block of two-digit values. Treatment group subjects completed the task by circling repetitions of the number 64 embedded in a block of numbers ranging from 60 to 69 (Appendix C). Control group subjects circled repetitions of the number 84 embedded in a block of numbers ranging from 80 to 89 (Appendix D). After completing the task, subjects wrote their name and the value circled on two 3" x 5" index cards. One card was concealed on the subject's person throughout the PDD examination and the second was retained for verification purposes. In an attempt to motivate subjects to be successful in their deception, they were told that it is extremely difficult to lie successfully during a PDD examination, and that only individuals with great emotional control and superior intelligence can do so successfully (Gustafson & Orne, 1963). Subjects were then escorted to an examination room and introduced to the examiner.

The examiner conducted a brief pre-test interview to gather biographical information (Appendix E); explain the purpose of the polygraph sensors and theory supporting PDD

examinations (Appendix F); and review the examination questions and sequence (Appendix G). Next, the arm cuff was placed over the brachial artery of the left arm, and the finger cuffs were placed on the subject's left and right thumbs. The arm cuff was then inflated to 90 mmHg, massaged to remove wrinkles, and deflated to 48 mmHg. The pressure was then adjusted, as necessary, to achieve a 2 mmHg sphygmomanometer deflection. Each of the finger cuffs was inflated to 50 mmHg, then deflated to 40 mmHg. These pressures were maintained throughout testing. The custom build amplifier DC offsets were then adjusted to zero to keep the signal within the range of the analog-to-digital converter, and polygraph sensitivity adjustments were made.

The test questions were asked three times (via digitized voice) in the same sequence during each examination. Subjects were instructed to answer "NO" after each question. If response artifacts occurred during questioning, the question was repeated immediately, and data collected during the first presentation of the question discarded. When a test was complete, all sensors were vented (i.e., ambient pressure restored), and the subject was allowed to move around in the examination chair (for approximately three minutes) before beginning the next test. During this time the examiner asked the subjects if they wished to discuss any of the thoughts they had during the examination. Questions were answered, without indicating the results of the previous test, and the second test commenced. The same procedure was observed between the second and third tests. After the third test, the sensors were removed, the subject debriefed (Appendix H), and the subject released. Data collected during all three tests were retained for off-line analysis.

Data Collection

Time-locked amplitude data from the three occlusive cuffs were digitized at a rate of 256 samples per second for the 15 seconds following the offset of each question asking and recorded on computer disk. A 100 point running average was used to remove 60 Hz artifacts. The first and last 50 data points of each sample were omitted during this process. Prior to data analysis, three research physiologists independently assessed the recorded waveforms to determine if movement artifacts were apparent in any of the three cuff measures. When at least two judges were in agreement regarding the presence of movement artifacts, that subject's data for the affected question were omitted from further analysis. Two data sets were analyzed. Set A consisted of left thumb and left arm data, and Set B consisted of right thumb and left arm data. Seventeen of 540 data pairs were dropped from Set A, and 11 of 540 from Set B due to artifacts.

Results

The time-locked amplitude variations on 3996 paired data points measured from the two finger cuffs and the arm cardiovascular cuff during each 15 second response epoch were assessed by Pearson correlation. It was necessary to time-shift the finger cuff signals to obtain a maximum correlation (i.e., because the finger measure is more distal than the arm measure, the pulse waveforms were time shifted). A correlation, between each finger and arm cuff measure, of 0.90 or greater was accepted as indicating that equivalent physiological

activity was measured from the arm and finger cuffs. This criterion was chosen, a priori, as a conservative estimate of waveform congruence. It can be seen in Figure 1 that when correlations between measures are greater than 0.90, the waveforms are visibly similar. However, correlations less than 0.90 are indicative of dissimilarity (see Figures 2 and 3). The right finger cuff tracings show a greater baseline shift than the left arm cuff tracing. In Figure 3, the amplitude change evident in the arm cuff tracing is not seen in the finger cuff tracings.

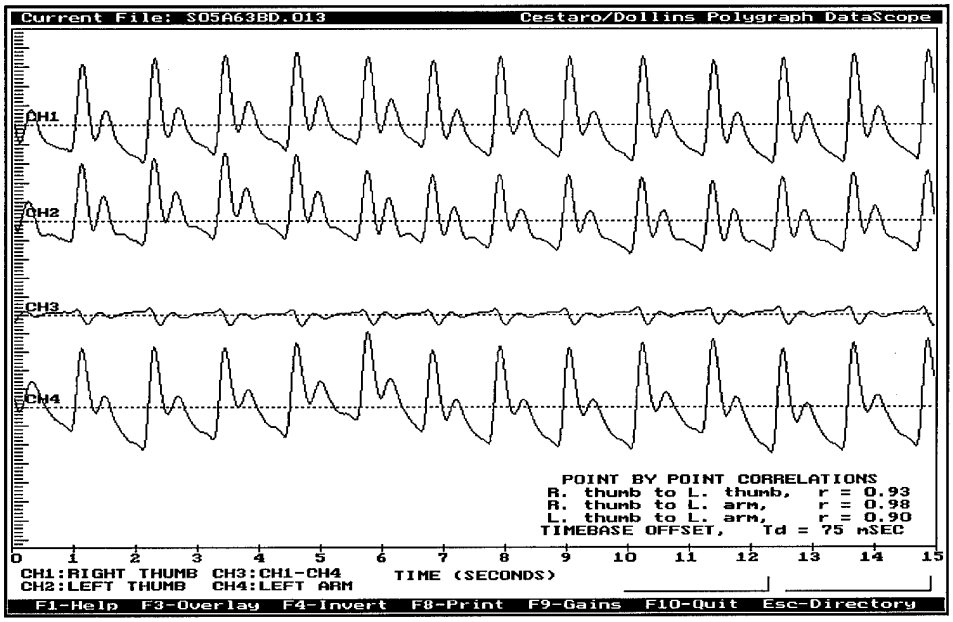


Figure 1. Cardio tracings depicting similar waveforms at three locations with $\underline{r}$ = 0.98 between the right thumb (CH1) and left arm (CH4).

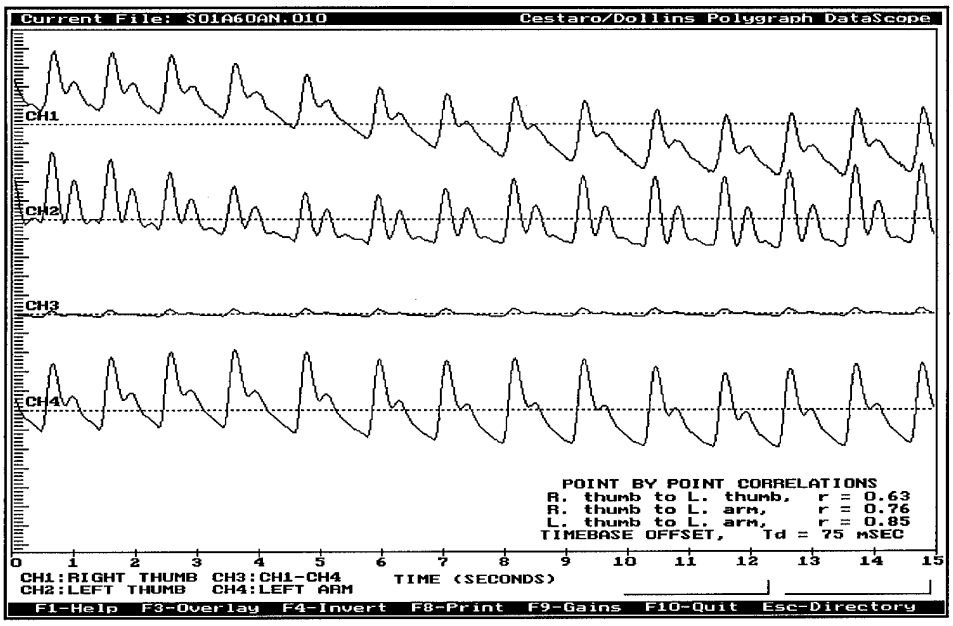


Figure 2. Cardio tracings depicting dissimilar waveforms at three locations with $\underline{r}$ = 0.76 between the right thumb (CH1) and left arm (CH4).

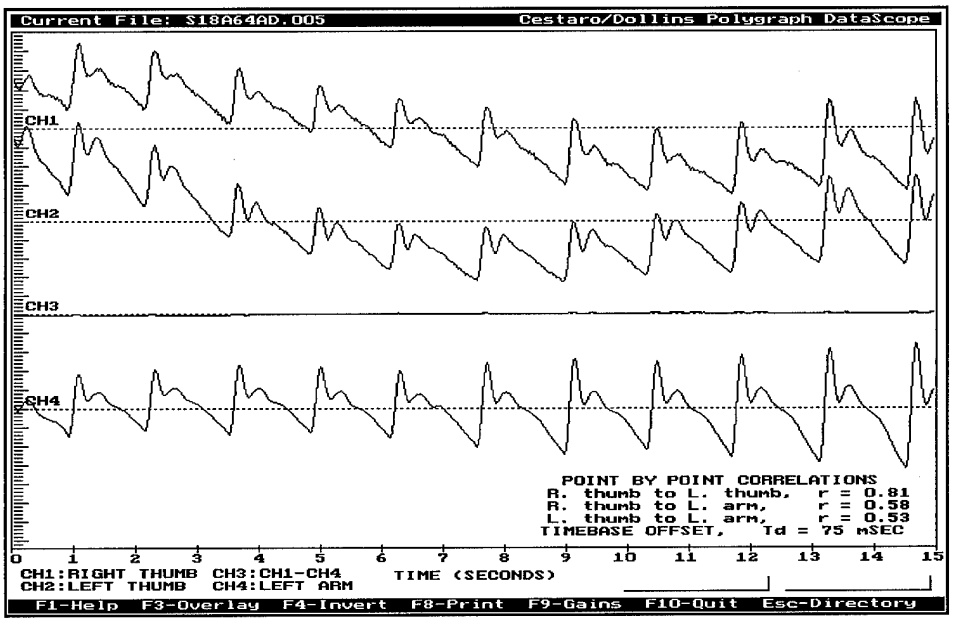


Figure 3. Cardio tracings depicting dissimilar waveforms at three locations with $\underline{r}$ = 0.58 between the right thumb (CH1) and left arm (CH4).

Within Set A (left thumb vs. left arm), 219 of 523 data pairs (42%) had Pearson correlations meeting the criterion ($\underline{r}$ = > 0.90). Within Set B (right thumb vs. left arm), 379 of 529 data pairs (72%) satisfied the criterion, indicating a higher rate of congruency

when the finger cuff and arm cuff were placed on opposite sides of the subject. The frequency of correlations equal to or greater than 0.90 are shown by group programming in Figure 4. Two hundred five (54%) of the 379 data pairs (Set B) came from the group programmed to be truthful and 174 (46%) were from the group programmed to be deceptive. No significant differences were found in the distribution of high correlations between the two groups within this data set ($Z = 1.45$, $p > .05$). However, within Set A, 151 data pairs (69%) came from the programmed truthful group, and 68 pairs (31%) were from the deceptive group ($Z = 5.11$, $p < .001$).

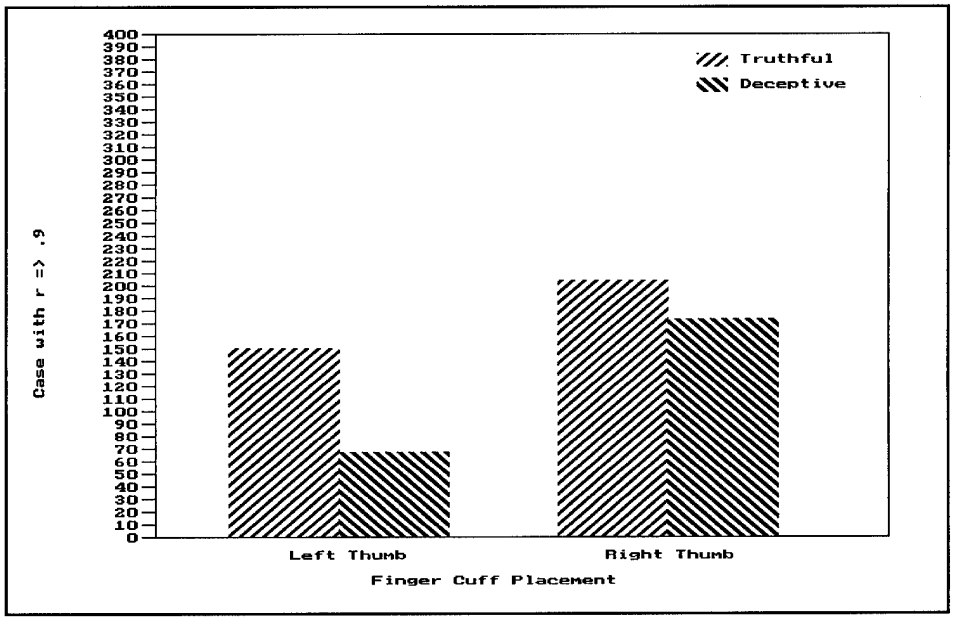


Figure 4. Frequency of cases by group with $r => 0.90$ between the left thumb and left arm, and the right thumb and left arm.

During data collection, the examiner made more baseline corrections for each of the two finger cuffs (left = 129, right = 115) than for the arm cuff (79).

Discussion

The results suggest that the Lafayette occlusive finger cuff is not an analog of the occlusive arm cuff currently used for measuring cardiovascular activity during the PDD. Congruent tracings were observed less than 75% of the time. Additionally, the PDD examiner made more finger than arm cuff baseline corrections, suggesting that the finger cuffs are more sensitive to blood volume changes than the arm cuff. The most obvious differences between the two types of sensors were differential baseline and amplitude variations. These variations frequently occurred in some subjects' data and rarely in others. The lower frequency of congruent signals observed when both types of sensors were placed on the subjects' left side may have been due to a rise in venous return pressure caused by the

occlusive arm cuff. This increased pressure may have caused the left finger cuff amplitude changes that were not observed on the concurrently measured arm cuff tracings. Movement artifacts were not a serious problem with either type of sensor.

When choosing a sensor to detect physiological activity, researchers should consider what the sensor is measuring and whether that measure is appropriate for assessing the response under investigation. Increased blood flow to major muscle groups may be readily assessed by the arm cuff. However, the finger cuff may be sensitive to blood flow away from the periphery. The differential blood volume changes noted between the two types of sensors suggest that the finger cuff is a more sensitive indicator of minor changes in this measure. Further research is needed to determine which cuff would provide the better measure of deception during PDD.

Poor mechanical integrity was a problem associated with the finger cuff assembly. The latex bladder used in the finger cuff developed leaks over time and had to be replaced periodically during testing. Some of the baseline shifts encountered early during the study were directly attributable to pin-hole bladder leaks and/or insufficient pressure from the "O" rings used to secure the bladder to the metal cuff assembly. As a further practical note, during pilot testing it was observed that large pen deflections occurred in response to small transient changes in barometric pressure (i.e., on and offset of air conditioning, opening and closing of examination room and external building doors) when the finger cuff was used and the Lafayette Cardio/Aux/Pneumo/GSR module sensor selector was set in the Cardio 2 position. These seemingly random pen deflections could lead to erroneous chart interpretation.

It is suggested that the occlusive finger cuff tested during this investigation not be adopted for used by forensic psychophysiologists. Because visual inspection of the data suggests that the finger cuff is more sensitive to changes in peripheral blood flow, testing of a finger cuff with a less problematic design should be considered. The current finger cuff design is not analogous to that of the traditional arm cuff. The finger cuff tested is composed of a pneumatic bladder inside a rigid metal tube. The entire finger is encircled by the bladder, thus, transient volume changes (i.e., those associated with blood flow through the princeps pollicis or radialis indicis artery) are distributed throughout a pneumatic area that is relatively large compared to the actual change in volume. The occlusive arm cuff consists of a bladder, which is placed over a major artery of the leg or arm, secured by a strap. A finger cuff composed of a small bladder, placed directly over the finger artery, held in place by a flexible, adjustable, but not elastic strap could prove more efficient and less problematic.

In conclusion, it was found that even though responses measured using the traditional occlusive arm cuff correlated highly ($\underline{r} => 0.90$) with those measured using finger cuffs placed on contralateral and ipsilateral thumbs on 72% and 42% of 529 and 523 trials, respectively, the measured responses were not analogous during a relatively high percentage of trials (28% and 48% respectively). The current occlusive finger cuff has a design

problem; however, it could prove more sensitive to peripheral blood volume changes than the traditional arm cuff. Although no attempt was made to evaluate the efficacy of either occlusive cuff sensor, the current results clearly indicate that tracings obtained with one sensor are significantly different from those obtained with the other. While the observed differences occurred more frequently in some subjects than others, no mediating factors were evident. It is suggested that: (1) the current occlusive finger cuff not be used in PDD examinations; (2) design and testing of a less problematic occlusive finger cuff be pursued; and (3) results of PDD accuracy determinations, in addition to correlations between measures, be obtained prior to deciding which sensor is the most suitable for use.

References

Davis, R. C. (1961). Physiological responses as a means of evaluating information. In A. D. Biderman & H. Zimmer (Eds.), The manipulation of human behavior (pp. 142-168). New York: John Wiley & Sons.

Gustafson, L. A., & Orne, M. T. (1963). Effects of heightened motivation on the detection of deception. Journal of Applied Psychology, 47, 408-411.

Lykken, D. T. (1981). A tremor in the blood: Uses and abuses of the lie detector. New York: McGraw-Hill.

Office of Technology Assessment (1983). Scientific validity of polygraph testing: A research review and evaluation - a technical memorandum (Report No. OTA-TM-H-15). Washington, DC: U.S. Government Printing Office.

Yankee, W. J. (1965). An investigation of sphygmomanometer discomfort thresholds in polygraph examinations. Police, 9(6), 12-18.

Appendix A

Description of Research

WELCOME: Welcome to the Department of Defense Polygraph Institute. This may be the first time you have been to the Institute so we would like to provide you with some information concerning your visit today. PLEASE REMEMBER that your participation is entirely voluntary - you are free to leave at any time. If you have any questions, please feel free to ask the individuals assisting you.

Research Title: A comparison of signals from two occlusive cuff cardiovascular sensors used for the psychophysiological detection of deception (February 22, 1994).

Principal Investigators: Dr. Victor L. Cestaro, DoDPI Research Psychologist
Dr. Andrew B. Dollins, DoDPI Research Psychologist

BACKGROUND / SIGNIFICANCE: The Psychophysiological Detection of Deception (PDD) is a process believed to determine whether an individual is responding truthfully to a series of questions. The PDD is commonly called a "lie detection" or "polygraph" examination. The process is based on the assumption that an individual who is deceptive (i.e., lying) has a greater response in some body systems than a person who is not. A blood pressure cuff is inflated throughout a PDD test - usually for three to five consecutive minutes. Some people find this cuff to be uncomfortable and distractive. We are currently conducting a study to compare data acquired via an occlusive finger cuff to those acquired using the traditional occlusive arm cuff. If the signals are comparable, it may be possible to reduce examinee discomfort during future DoD PDD examinations without loss of accuracy.
YOU SHOULD NOT PARTICIPATE IN THIS STUDY IF YOU:

1) Previously participated in a PDD examination.
2) Are taking prescription medication.
3) Have a history of dizziness or fainting spells.
4) Have been diagnosed with a heart condition.
5) Have been diagnosed with high blood pressure.
6) Have been diagnosed with a respiratory ailment, especially asthma or emphysema.
7) Currently suffer from an acute health problem such as a cold, active allergy problem, hemorrhoidal problem.

PROCEDURES: During this project you will be asked to participate in a test session lasting approximately four hours. You will be asked to complete a puzzle and, possibly, to lie about the puzzle during a PDD examination. Some people will be asked to lie about the puzzle they completed and some will not be asked questions about the puzzle. If you are asked questions about the puzzle you completed, YOUR TASK IS TO LIE SUCCESSFULLY, to the PDD examiner concerning the puzzle.

Participation in the PDD process is relatively simple. The examiner will ask several questions concerning your age, health, and normal daily activities. He will then briefly explain the theory of the Psychophysiological Detection of Deception and review the questions he will ask during the examination with you. With your permission, the examiner will then attach sensors to your body. Two small flat metal sensors will be attached to the first and third fingers of one hand. Expandable tubes will be put around your upper and lower chest. A blood pressure cuff will be wrapped around your arm. An aluminum band, similar to a ring that is 20 sizes too large, will be placed over a thumb. You will be asked to sit still for several minutes while the examiner asks the questions he reviewed earlier. The examiner may ask the same questions several times during the examination. When the session is complete, you will be debriefed and your participation will be complete.

DISCOMFORTS: Some people find it difficult to sit still for several minutes at a time during the PDD test while physiological reactions are recorded. Part of the PDD process requires the wearing of an inflated blood pressure cuff, which some people find moderately uncomfortable. The examiner is sensitive to this discomfort and will attempt to make the process as brief as possible. The actual tests last approximately five minutes each. You will be asked to participate in as many as four tests during the examination. The total length of time that you will actually be participating in a polygraph examination is 30 to 45 minutes, however, you may be at DoDPI for three or four hours.

VIDEOTAPING: All examinations conducted during this project will be videotaped using wall and ceiling mounted video cameras and commercial videotape recorders. The tapes collected will be maintained until the operational and data analysis portions of the project are complete. At that time the video tapes will be erased and made available for re-use by the research and instruction divisions.

RISKS: There are no known risks involved in this study.

CONFIDENTIALITY OF RECORDS: You will not be asked any personal questions by the examiner, except those concerning medically related information necessary for this study. Neither your identity nor any information you reveal during this project will be released to anyone not directly involved in the research. Members of the U.S. Army Surgeon General's Human Subjects Research Review Board may inspect the research records in their capacity as reviewing officials.

YOUR RIGHTS: You have the right to ask any questions about any aspect of your participation in the study. If any problems arise at any time in conjunction with your involvement in the study, or if you have been injured in any way as a result of the study, the person to contact is the Chief of Research, Department of Defense Polygraph Institute. In the event that you do have questions or any of the above has occurred please contact Dr. William Yankee at (205) 848-3803. Should any question arise concerning study-related injury, you may contact the Director of the Noble Army Community Hospital, Fort McClellan, Alabama, 36205, telephone number (205) 848-2200.

VOLUNTARY PARTICIPATION: Your participation in this study is completely voluntary. **If you would prefer not to participate, do not volunteer for it!** Even if you decide to participate in the study, you may discontinue at any time without penalty or loss of benefits to which you are entitled. Should you decide not to participate, please inform someone on the staff at the Department of Defense Polygraph Institute, or if it occurs during the polygraph examination itself, inform the examiner and you will be released without censure.

ADDITIONAL COMMENTS: Regardless of whether you are required to lie during the PDD examination, it is very important that you do not tell the examiner whether you are being truthful or not. Examiners should not ask and if they do, please tell another staff member. It is also VERY IMPORTANT that you do not discuss your experiences in the PDD examination with your fellow research participants. If either of the above occurs, you will be withdrawn from the study without further benefit.

Appendix B

Informed Consent Affidavit

This form is affected by the Privacy Act of 1974.

1. **AUTHORITY**: 10 USC 3012, 44 USC 3101 and 10 USC 1071-1087.

2. **PRINCIPLE PURPOSE**: To document voluntary participation in a DoD Polygraph Institute Research Program.

3) **ROUTINE USES**: Your name will be used for identifying and locating research documents and will be available only to individuals associated with the research project.

4. **MANDATORY OR VOLUNTARY DISCLOSURE**: Your signature is necessary if you want to be included in this research. If you do not sign, you will not be able to participate in this study and you will not be paid.

PERSONAL STATEMENT

I, _____, being at least 19 years old, do hereby volunteer to participate in a research study titled "A Comparison of Signals from Two Occlusive Cuff Cardiocvascular Sensors Used for the Psychophysiological Detection of Deception" being conducted at the Department of Defense Polygraph Institute, under the direction of Drs. Victor L. Cestaro and Andrew B. Dollins.

1._____ I understand that I am participating in a research study to examine several measures and techniques, some of which are currently employed in criminal and/or security screening situations where the Psychophysiological Detection of Deception (PDD) is used. PDD is commonly called a 'polygraph test' or 'lie detector'.

2. To the best of my knowledge,

A._____ I am not taking any prescription medication.

B._____ I have no history of dizziness or fainting spells.

C._____ I have not been diagnosed as having, nor do I believe that I may have any of the following:

1) Heart condition.

2) High blood pressure.

3) Any respiratory ailment, especially asthma or emphysema.

D._____ I do not now have any acute health problems such as a cold, an active allergy problem, and an active hemorrhoidal problem.

3._____ I am aware that I will be spending approximately four (4) hours at the Department of Defense Polygraph Institute (DoDPI), and that I may be asked to conceal information concerning my activities at DoDPI from a trained Forensic Psychophysiologist.

4._____ I understand that as a part of this study I will be participating in a PDD examination during which I will be asked to sit still for several minutes at a time while physiological measurements are recorded from my body.

5._____ I understand that there are no known dangers or risks associated with my participation in this study.

6._____ I understand that I will be required to wear an inflated blood pressure cuff, which some people find moderately uncomfortable, during the PDD examination.

7._____ I understand that I will be videotaped during the PDD examination and that the videotape will be maintained until data analyses are complete.

8._____ I understand that I will receive no reward or benefit of any kind as a result of my participation in this study.

9._____ I understand that I may terminate my involvement in this study at any time and for any reason, without censure.

10._____ I understand that my participation in this project will be terminated if I discuss the details of my participation with anyone except project supervisory personnel. NOTE: Discussion of details with other participants would invalidate the data collection.

11._____ I understand that I should contact the principal investigator, Dr. Victor Cestaro, Dr. Andrew Dollins, and / or the DoD Polygraph Institute Director, Dr. William Yankee [Telephone number: (205) 848-3803] if I have any concerns or complaints regarding this study.

12._____ I understand that any questions concerning my rights relating to study-related injury should be directed to Colonel Weisser, MD, Director of the Noble Army Community Hospital, Fort McClellan, Alabama, 36205, telephone number (205) 848-2200.

13._____ I have been given a thorough explanation of the nature, purpose, methods, and duration of my participation in this investigation. I have been given the opportunity to ask any questions I have concerning the investigation and all questions have been answered to my full satisfaction.

_____	_____
Participant Signature	Witness Signature
_____	_____
Printed Name	Printed Name
_____	_____
Date	Date

Appendix C

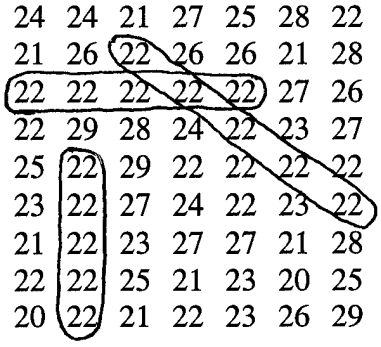
Anagram Task 64

Please locate and circle six sequences of the number which is repeated five times below. (See example for the number 22 on the right.)

Name:_____

Subject #:_____ Date:_____

Score:_____ (EoRPDD 07/12/93 6A)



66 62 64 61 61 63 65 64 67 66 66 66 61 64 63 64 65 66 67 62
68 69 63 66 67 61 65 68 68 67 68 68 65 65 65 66 68 63 68 68
68 62 69 62 65 66 64 64 64 64 64 68 69 66 66 66 61 62 67 66
61 64 63 61 63 66 68 69 69 64 69 67 66 66 63 63 65 60 62 65
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68 60 68 69 68 65 63 60 63 69 65 68 67 67 65 64 67 68 66 65
64 69 65 62 60 62 60 65 62 69 68 62 67 61 61 64 67 68 62 63
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63 69 61 67 63 64 67 67 62 67 67 64 63 69 64 64 68 67 61 61
60 62 62 65 64 68 64 67 61 68 61 67 62 64 63 61 62 62 69 65

(Truncated)

Appendix D

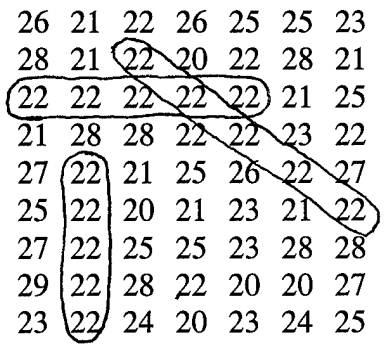
Anagram Task 84

Please locate and circle six sequences of the number which is repeated five times below. (See example for the number 22 on the right.)

Name:_____

Subject #:_____ Date:_____

Score:_____ (EoRPDD 07/12/93 8A)



86 82 84 81 81 83 85 84 87 86 86 86 81 84 83 84 85 86 87 82
88 89 83 86 87 81 85 88 88 87 88 88 85 85 85 86 88 83 88 88
88 82 89 82 85 86 84 84 84 84 84 88 89 86 86 86 81 82 87 86
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80 82 82 85 84 88 84 87 81 88 81 87 82 84 83 81 82 82 89 85

(Truncated)

Appendix E

Pre-Test Questionnaire

Participant number:_____ Date of completion:_____

Please carefully complete all of the blanks below:

Name (Please Print):_____ Gender:( )M ( )F

Occupation:_____ Age:_____

Hours of sleep last night:_____ Previous PDD Examination: ( )Yes ( )No

Have you ingested alcohol, nicotine, or caffeine (including coffee, tea, soft- drinks, and chocolate) within the last 24 hours? ( )Yes ( )No

If so, what and when?_____

_____

How would you describe your present health and physical well being?
( )Excellent ( )Good ( )Fair ( )Poor

Are you presently under a physician's care and are you taking any medication? ( )Yes ( )No

If so, for what condition?_____

Please identify the type, dosage, and last time any medication was taken:

_____

Are you experiencing any pain or discomfort today?
( )None ( )Mild ( )Moderate ( )Severe

Reason for any pain or discomfort today:_____

_____

Appendix F

Pre-Test Explanation of Procedures

Hello, my name is _____, I will be administering your psychophysiological detection of deception examination today.

Before we begin the examination, I will explain how the polygraph instrument is used to determine if someone is being deceptive. This instrument amplifies and records activity from your body. Today we will use:

1) The cardiovascular cuff (show cardiovascular cuff - where and how attached) which measures blood pressure or volume and heart rate.
2) The finger cuff (show finger cuff - where and how attached) which also measures blood pressure or volume and heart rate.

Research indicates that the signals recorded from these sensors are normally constant. When an individual becomes aroused or is stimulated, as occurs when lying, the signals change. Basically, the brain and parts of the nervous system control the level of physiological activity in the body. When a person is asked a question that they know the answer to, there are two basic mental processes that occur in the brain. First, the person understands the question. Second, the correct answer is automatically determined and/or recalled. For example, if I ask the question, "Are you in the state of Alabama?". As soon as your brain understood the question, it (the brain) located and identified the truthful answer, which is YES. Your brain did not first decide that you were in Alaska, and then correct itself. The brain identified the truthful answer before you even decided to say YES or NO. If you had decided to say YES, there would have been no mental stress or struggle within yourself to answer that question because your brain knew the answer to be YES and it could have easily caused you mouth to say YES. If you decided to lie about the state you are in, you are causing your brain to expend extra mental effort to change the automatic truthful response into a deceptive response. During this conscious mental effort to lie, the brain changes (decreases) its monitoring of other body activities, such as breathing, heart beating, and sweat gland activity, so their level of activity changes. When you tell the truth, physiological activity changes very little. Lying takes more mental effort. When a person lies, physiological changes occur in their body because the brain changed the amount of energy it was using to control those activities. The polygraph instrument is constantly recording the level of physiological activity within the body, so the changes resulting from a person telling a lie are recorded and can be identified.

During the examination, I would like for you to sit up straight and look straight ahead. Try not to move your body or head during the examination. Such movements will change the signals from your body and I will have to repeat the question, and possibly the complete examination.

I will now review all of the questions that I will ask you today. Before I begin asking questions, I will say: "The test is about to begin, sit perfectly still, answer all questions with a NO, and keep your eyes open during the test." I will then ask the following questions, in order (See Appendix G for question list). I will tell you when the examination is complete, but ask you to remain still for a few more moments while I turn down the amplifiers, so we don't damage the instrument. Sometimes there are problems with the recording because examinees do not remain still. If this occurs, I will repeat the question again - don't be surprised by this. This is fairly normal, so don't be surprised if I repeat a few questions today.

BEGIN EXAMINATION:

BETWEEN TESTS:

Do you wish to discuss any of the thoughts you had during the examination?

Appendix G

PDD Test Questions

X The test is about to begin.

Q01 Did you complete a search task for the number 60?

Q02 Did you complete a search task for the number 61?

Q03 Did you complete a search task for the number 62?

Q04 Did you complete a search task for the number 63?

Q05 Did you complete a search task for the number 64?

Q06 Did you complete a search task for the number 65?

Q07 Did you complete a search task for the number 66?

XX The test is now complete, please continue to sit still while I turn the instrument off.

Appendix H

Participant Debriefing Statement I

Now that you have completed your examination, it is the desire of the entire project staff to take this opportunity to sincerely thank you for your help. Your work here may be more important than you realize.

If you participated in deceiving the PDD examiner, you are assured by the staff of this Institute, that you in no way violated any rule or law. The deception was required for research purposes only.

Regardless of the role you played, it is our hope that you were made to feel as comfortable as possible throughout the study. If you do have concerns or questions regarding your participation, please make them known to the principal investigators, Dr. Victor Cestaro or Dr. Andrew Dollins, and / or the DoD Polygraph Institute Director, Dr. William Yankee [Telephone number: (205) 848-3803].

Finally, it is VERY IMPORTANT that you DO NOT discuss the details of this study with anyone else. One of your friends, or a friend of a friend, may decide to participate in this or a similar study someday. If they know the details of the investigation process, they could be disqualified from participating in a study and/or unconsciously influence the results of the study using their GUILTY KNOWLEDGE. If you reveal the details of this study to another person we will also be forced to terminate your participation in this study.

Please sign this form in the space provided to indicate that you understand the instructions provided above.

_____

Participant Signature

_____

Printed Name

_____

Date